EARTHQUAKE-INDUCED LANDSLIDES: FROM HISTORICAL DATA TO NEW EMPIRICAL RELATIONSHIPS

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Purpose: We present a new database of historical earthquake-induced landslides (EILs) for the Italian territory, developed in framework of the CFTI5Med historical earthquake catalogue (https://storing.ingv.it/cfti/cfti5/) with a twofold goal: 1) extending back in time the knowledge of seismic induced environmental effects so as to be able to forecast scenarios of future large events (i.e. with M>5.5), and 2) to develop new empirical relationships connecting landslide distribution and seismic parameters.

Method: We first revised the database of seismic-induced environmental effects connected to the CFTI historical seismic catalogue, collecting and analysing new historical sources and revising those already studied in the past. In addition, we analysed recent scientific articles and technical reports and made comparisons with other digital archives such as the CEDIT (https://doi.org/10.4408/IJEGE.2012-02.O-05) and the EEE catalogues (http://eeecatalogue.isprambiente.it/). As a second step, we tried to accurately locate the historical EILs in a GIS environment using the coeval descriptions and comparing them with topographic maps and geographic names. In some cases, it was possible to associate individual EILs with landslides already included and described in the Italian Landslide Inventory (IFFI database https://www.progettoiffi.isprambiente.it/). The third step was aimed at the development of new empirical attenuation relationships using the implemented database. To do so, we related the variation of EILs density with distance from the epicentre as a function of the earthquake magnitude. The seismic events were subdivided into three magnitude classes to account for the different extent of the maximum area affected by EILs and released energy. In addition, using the shake maps of 38 out 159 historical earthquakes of our dataset, we also developed a new empirical relationship relating the variation of EILs density with distance as a function of the peak ground acceleration.

Results: The result of this work is a new database of historical EILs, composed of more than 1,000 landslides associated with more than 150 historical earthquakes or seismic sequences occurred between 117 b.C.E. and 1997. Each EIL is classified on the basis of the accuracy of its location and of the slope movement type. The updated dataset is collected in the new CFTI Landslides database, connected to but independent from the CFTI5Med database, and it is publicly accessible online through a dedicated open-source geographic interface, designed to be interoperable with both INGV and external databases through dedicated web services. As empirical results, we found that the cumulative density of EILs decreases with distance from the earthquake epicentre following a power law relationship and the power law relationship derived from PGA value shows the increasing landslide density with increasing acceleration, defining a threshold value of PGA between 0.2-0.3 g.

Conclusions: The implementation of the new historical EIL database for the Italian territory, on one hand allowed for a better definition of the environmental effects triggered following large earthquakes, on the other hand, dramatically increased the number of data points available for deriving empirical relationships and consequently their statistical significance.